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GEL MINERALS (COLLOID MINERALS)

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A subject of growing importance to the mineralogist at the present time is that of the part colloids play in the formation of minerals. The application of colloidal chemistry to other branches of practical science has been extensive, but until very recently little work has been done from the mineralogical point of view. The existence of minerals which have had a colloidal origin has long been recognized, but our means of identifying them has been almost entirely from their external appearance and occurrence. The object of the work described in this paper was to secure some method for their identification. While no results of a positive nature were obtained, a few things of interest may be presented.

In order that the reader may obtain a rather clear conception of the subject of colloidal chemistry, a few definitions and descriptions of phenomena exhibited are given here:

Colloid. This refers to a condition or state of matter. As Wolfgang Ostwald points out² "we can speak of 'colloids' only as we speak of 'crystals,' 'amorphous substances,' 'soluble and insoluble' substances, or, better still, 'gaseous, liquid and solid' substances. *All substances can appear as colloids under appropriate conditions.*" In other words, any chemical compound may appear either as a colloid or as a crystalloid.

There is no relation between chemical composition and colloidal condition. However, what Ostwald characterizes³ as a law governing the relation is "The more complex chemically the compound, the greater the probability that it is in a colloidal state." As an example he gives gelatin, a compound the formula of which has never been definitely determined.

Phase. By a phase is meant any homogeneous part of a system different from the other parts of the system and separated from these by abrupt transitions. Dispersed phase is the finely divided, discontinuous phase. Dispersion-means is defined as the continuous or closed phase. In the case of colloidal suspensions the dispersed phase is a solid and the dispersion-means a liquid.

¹ Thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts in the Faculty of Pure Science of Columbia University, 1916.

² Ostwald (Fischer) Handbook of Colloid-Chemistry. [1st English edition.] P. Blakiston's Son & Co.: Philadelphia, 1915; p. 2. ³ *ibid.*, p. 2.

When dealing with emulsoids the dispersed phase is a liquid and the dispersion-means a liquid. As Ostwald points out⁴ the dispersed phase and dispersion-means are geometrically and structurally different.

Sol. A term introduced by Thomas Graham, which means a colloidal solution, or, as Ostwald states⁵, is a special name for spatially homogeneous systems.

Gel. A gel he defines⁶ as a system in the course of passing to or from a condition of spatial homogeneity.

Hydrosol. In the case of the hydrosol the dispersion-means is water and the dispersed phase is the substance in the colloidal condition. In addition there are alcosols (alcohol sols), sulfosols (sulfuric acid sols), organosols (in which the dispersion-means is an organic liquid). Corresponding to these we have hydrogels, sulfogels and organogels. In nature the most widely distributed sols are no doubt hydrosols, but sulfosols and organosols may play an important part. The reactions which go on are by no means simple.

Adsorption. A property which gels possess to take up foreign material from solution. Example: the barium and potassium content of psilomelanite.

When a change in state of a colloid may be reversed by reversing the conditions which produce that change, it is said to be reversible. In Colloidal Chemistry we have both reversible and irreversible colloids. Among minerals the only reversible colloid is said to be ilsemanite.⁷

Isocolloid. When the dispersed phase and the dispersion means have the same chemical composition, the system is known as an "isocolloid."

Tyndall Ray Phenomena. It is a common experience to observe the dust particles in the air when a beam of sunlight is admitted to a darkened room. These particles are made visible by unequal illumination. This is the basis of the Tyndall ray effect.

A strong arc with a suitable system of lenses produces a beam of light which makes visible fine particles dispersed in a liquid or other medium. It is upon this principle that the ultra-microscope depends.

A useful apparatus for producing a Tyndall ray can be made by using a small arc light placed behind a camera box. By removing the lens and substituting a low-power objective from a microscope, a very fair light cone is produced for rough work. The adjustable diaphragm on the camera makes it possible to obtain a suitable sized cone. The solution to be tested can be placed on the stage of a microscope, in a thin-walled glass vessel,

⁴ *ibid.*, p. 25.

⁵ *ibid.*, p. 24.

⁶ *ibid.*, p. 24.

⁷ The nature of this mineral has been, however, misinterpreted: see Schaller, *J. Wash. Acad. Sci.* 7, 417, 1917. [Editor.]

and the light cone directed thru it. By focussing on the narrow part of the ray very good effects are produced.

Brownian Movements. All dispersoids that have a liquid or gaseous dispersion-means and a sufficiently great degree of dispersion show certain movements. This phenomenon was discovered by Brown, an English botanist, and named after him. Zsigmondy has described the movement in colloidal solutions as "hopping, skipping and dancing."

In the case of microscopic particles the movement is along a curved path, while smaller particles move in straight lines and change their direction suddenly.

Brownian movements may be observed in metal hydrosols, metal sulfide hydrosols, animal and vegetable milks, also in tobacco smoke and cooling ammonium chloride vapors. The movements can be observed satisfactorily only under high magnification.

Since colloidal solutions are merely a special case of dispersoids, Ostwald⁸ has classified the dispersoids by taking the three states of matter—solid, liquid, and gas, and has obtained the following nine possibilities:

1. Solid + solid. 2. Solid + liquid. 3. Solid + gas. 4. Liquid + solid. 5. Liquid + liquid. 6. Liquid + gas. 7. Gas + solid. 8. Gas + liquid. 9. (Gas + gas).

Examples:

1. *Solid + solid.* Intercalations of foreign particles in minerals (microliths, etc.), carbon particles in iron, of coloring matter in mineral salts and precious stones, "solid" colloid solutions, mixed crystals, solid solutions.

2. *Solid + liquid.* Liquid intercalations in many minerals; water of occlusion, inclusion, and crystallization.

3. *Solid + gas.* Gaseous inclusions in many minerals (meerschäum, pumice stone, lava, tufa), solutions of gases and solids (hydrogen in iron, etc.).

4. *Liquid + solid.* Suspensoids.

5. *Liquid + liquid.* Emulsoids.

6. *Liquid + gas.* Foams.

7. *Gas + solid.* Smoke, for example, tobacco smoke; condensing metallic vapors; cooling vapors of ammonium chloride; cosmic dust, etc.

8. *Gas + liquid.* The fog formed at the liquefaction point of gases or in the condensation of steam, atmospheric fogs, clouds, Tyndall photo-chemically produced liquid fog, etc.

9. *Gas + gas.* Since gases are completely miscible in each other in all proportions, no examples are known.

Of these the ones of most importance are Nos. 4 and 5 to the colloidal chemist in general, while to the mineralogist the one of primary importance is the fourth, namely, "suspensoids."

⁸ Handbook of colloid-chemistry, p. 43.

THE COMPOSITION OF SELENIFEROUS
SULFUR

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Selensulfur is classed by Dana¹ as a mineral species, No. 4, and is described as "a reddish brownish mineral containing sulfur and selenium, but in unknown proportions." Several months ago an authentic specimen of this mineral was procured from the United States National Museum for analysis. It showed such small amounts of selenium, as compared with the artificial alloys of these elements which have been prepared, that the suggestion was made that the term "seleniferous sulfur" would be more appropriate for it than selensulfur and that it should be regarded as a variety of sulfur rather than as an independent mineral species.²

In order to ascertain whether the small amount of selenium was unique in the particular sample analyzed, or was characteristic of the material in general, an attempt was made to obtain for analysis additional specimens of the mineral from as many different localities as possible. Six specimens, in addition to that previously analyzed, were secured, as follows: two each from the National Museum (thru Dr. Wherry); the Mineralogical Museum of Columbia University (thru Prof. Moses and Dr. Wherry); from the Museum of the Mineralogical Department of the University of Pennsylvania, thru Prof. Amos P. Brown.

Selected portions of the minerals were powdered and treated with bromine, and the selenium was determined by the method of W. Smith³. The bromide of selenium was decomposed by the addition of successive small amounts of bromine water, the solutions were filtered and the selenium precipitated from the combined filtrates by potassium iodide and hydrochloric acid. The solution was boiled to convert all of the selenium to its black modification, filtered thru a Gooch crucible, the precipitate washed with hot water, and the selenium finally weighed as the element. The results are shown in Table 1, page 117.

No. 1 is the specimen previously studied, described in the paper above cited. In this the material was mixed with lava, and the Se-content of the rock as a whole was obtained and recalculated to 100% of sulfur+selenium. In the others practically everything went into solution in bromine. No. 7 was peculiar in being unusually dark in color, and in developing more heat than the others when treated with the bromine, but only an unweighable trace of selenium was present; this result was confirmed on a duplicate sample. Evidently the brown colors of seleniferous sulfur are not connected with the selenium content,

¹System of Mineralogy, 6th ed., 10, 1892.

²*Am. J. Sci.* [4], 42, 132-4, 1916. ³*J. Ind. Eng. Chem.* 7, 849, 1915.

for pale yellow specimens may contain much more of this element than deep brownish ones.

The above results show that selenium is uniformly present in

TABLE 1. ANALYSES OF SELENIFEROUS SULFUR.

No.	Locality	Source	Color	Formation	Se content
1	Kilauea	U. S. N. M. 12901	Orange	Volcanic sublimate	5.18 %
2	New Zealand	Univ. Pa., Cope coll.	Pale orange-yellow	Volcanic sublimate	0.298
3	Lipari	Col. Univ.	Pale brown-yellow	Volcanic sublimate	0.285
4	Lipari	Col. Univ.	Pale yellow	Volcanic sublimate	0.272
5	New Zealand	U. S. N. M. 48056	Orange-yellow	Deposit from solution	0.195
6	Sicily	U. S. N. M. 60864	Brown-yellow	Deposit from solution	0.070
7	Sicily	Univ. Pa.	Brown-yellow	Deposit from solution	Trace

very small amounts in the so-called selensulfur, so that the appropriateness of regarding this as a variety rather than a species, and of naming it seleniferous sulfur, is established.

THE ASSOCIATION OF PYRITE AND STILBITE IN NEW JERSEY

ARTHUR P. HONESS

Princeton University

The surprising rarity of pyrite in the zeolite localities of New Jersey, as remarked by Prof. J. Volney Lewis¹, has given rise to a careful examination, by the writer, of the associations at various localities. The Paterson localities failed to add anything new, but several specimens from Lambertville and Moore, N. J., supplied to the writer thru the kindness of Professor Marcus Farr and Mr. Ralph H. Cutler of Princeton University, reveal the presence of this mineral in appreciable quantities. It occurs as a lustrous coating of small crystals on calcite and stilbite, and as well formed individuals evenly distributed over large specimens of light colored stilbite. Occasionally individual crystals may be observed enclosed in the stilbite and calcite, but this is exceptional, most of the pyrite being superficially implanted on the stilbite during the last stages of stilbite deposition. The pyrite crystals are usually cubical, often with small octahedral faces. They are simple or multiple crystals, varying in size from $\frac{1}{2}$ mm. to 2 mm., and possess a brilliant luster. Beautiful groups of interpenetration twins and drusy clusters are frequently observed. Chalcopyrite may be present in masses varying in size, but well formed crystals are not associated with the pyrite.

¹ *Am. Min.*, 1 (6) 92, 1916.

AN ELEMENTARY INTRODUCTION TO CRYSTALLOGRAPHY

J. P. WINTRINGHAM

*Brooklyn, New York**(Continued from page 110)*

There is another form that is more difficult to picture to one's self but is well worthy of study. It cuts one axis near the center and the other two further out, or at their ends, so its symbol would be 211. On the face of an octahedron (222 which is the same as 111) its plane rises from one corner towards the other corners equally far out or at the ends. A little thought will show that three such planes will cut each other in a point in the center of a triangle drawn to represent the face of an octahedron and in a line to the middle of each side. This pyramid 211, it might appear, could not cut the edges of the octahedron; but that is taken care of by the pyramid on the next octahedron face. If we represent one of these pyramids by a triangle, with a point in its center joined to the middle of each side we should break each side at those points and push them a little further out. The important relation is that each of our pyramid faces is bounded by four edges, two from the apex of the pyramid and two from the corners of the octahedron. So this form is called a tetragonal tris-octahedron.

There is only one more fundamental form, which need not be described so elaborately. It has forty-eight sides and may be called an eight-faced cube or a six-faced octahedron. The eight-faced pyramid on each face of the cube may be shown by drawing a square connecting the opposite corners and the centers of the opposite edges.

The six-faced pyramid on each face of an octahedron may be shown by drawing a triangle as previously and drawing a line from each corner to the center and continuing them to the middle of each edge. Accordingly this form is called the hexoctahedron; its symbol would be three different numbers, as (321). Our four last symbols (210), (221), (211) and (321) would represent the same kinds of forms if they had been respectively (310), (441), (522) and (732), etc. There would then be slightly different slants or angles or relative heights to the pyramids. There are three forms (100), the cube, (111), the octahedron, and (110), the dodecahedron, which are invariable; and the remaining four are subject to variation in the above described manner.

(To be continued)

NOTES AND NEWS

Dr. Edgar T. Wherry, one of the associate editors of this magazine, has been transferred from the position of Assistant Curator, Division of Mineralogy and Petrology, U. S. National Museum, which he has held for the last four years, to that of Crystallographer, Bureau of Chemistry, U. S. Department of Agriculture.

NEW MINERALS

Merrillite

MERRILLITE, METEORITIC CALCIUM PHOSPHATE. Edgar T. Wherry, Washington, D. C.

In two recent papers¹ Dr. George P. Merrill, of the National Museum, has called attention to the existence of a calcium phosphate mineral in a number of stony meteorites. As the properties of this substance agree more or less closely with francolite it was provisionally referred to that species. It differs from francolite however, in several respects, as shown in the following table:

TABLE 1.

PROPERTY	FRANCOLITE	MERRILLITE
Crystallization	Pseudo-hexagonal, built up of six sectors.	Not built up of sectors.
Optical character	Often pseudo-uniaxial	Always biaxial
Optical sign	Negative	Positive
Composition	$10 \text{ CaO} \cdot \text{CaF}_2 \cdot 3\text{P}_2\text{O}_5 \cdot \text{CO}_2$	$x\text{CaO} \cdot y\text{P}_2\text{O}_5$; apparently free from F and CO_2 .

These differences are sufficient, in the writer's opinion, to indicate the meteoritic phosphate to be a distinct species, and it seems appropriate that this species should be named after its discoverer.

¹ On the monticellite-like mineral in meteorites. . . *Proc. Nat. Acad. Sci.* **1**, 302-308, 1915; On the calcium phosphate in meteoric stones. *Am. J. Sci.* [4], **43**, (4), 322-324, 1917; abstract in *Am. Min.*, **2**, (7), 96, 1917.

ABSTRACTS OF MINERALOGICAL LITERATURE.

A PECULIAR PROCESS OF SULFUR DEPOSITION. Y. OINGUYE, Cornell University. *J. Geol.* **24**, (8) 806-808, 1916.

A description of the formation of hollow spindle-shaped grains of sulfur in crater lakes by the decomposition of ascending sulfurous gases. E. T. W.

A DISCOVERY OF CELESTITE. W. MALLERY. *Mining Sci. Press*, **113** (27) 952, 1916.

Fibrous crystalline celestite of typical color occurs 4 miles northeast of Lavic, San Bernardino Co., Cal. It is believed to have been formed by replacement of limestone by hot solutions. E. T. W.

A NEW SCHEELITE DISCOVERY. W. H. STORMS. *Mining Sci. Press.*, **113** (22) 768, 1916.

A note on the occurrence in Kern Co., Cal., of scheelite in association with garnet in metamorphosed limestone. E. T. W.

RECENT WORK ON MONAZITE AND OTHER THORIUM MINERALS IN CEYLON. ANONYMOUS. *Bull. Imp. Inst.*, **14**, 321-369, 1916.

Includes notes on the occurrences of monazite, thorianite, xenotime, zirkelite, and rhodolite garnet. E. T. W.

NOTES ON ALUNITE, PSILOMELANITE AND TITANITE. EDGAR T. WHERRY. *Proc. U. S. Nat. Mus.* 51, 81-88, 1916.

Analyses by J. E. Whitfield and W. K. Bailey of a phosphate-bearing alunite from Gonzales Co., Texas, and sodium-bearing alunites from the Funeral Range Mts., near Death Valley, Cal. are given, with descriptions of their physical and chemical properties. As advocated by the writer elsewhere, the group, as an isomorphous series, is assigned the name *alunite*, the K-end-member becomes *kalioalunite*, and the Na-end-member *natroalunite*. The phosphoric oxide is assigned to a molecule with the HPO_3 replacing the SO_4 of alunite, $\text{R}_2\text{O} \cdot 8\text{H}_2\text{O} \cdot 3\text{Al}_2\text{O}_3 \cdot 2\text{P}_2\text{O}_5$, or $\text{R}_2\text{H}_4[\text{Al}(\text{OH})_2]_6(\text{PO}_3)_4$, the same ratio of K:Na being used. Altho the K and Na salts of this radicle are only known as isomorphous replacements, the names *natrohitchcockite* and *kaliohitchcockite* are given to them, as members of the "hitchcockite" group, containing goyazite (*hamlinite*), probably the strontium salt; *gorceixite*, a barium salt; *plumbogummite* (*hitchcockite*) a lead salt; and *florencite*, a cerium salt. It is also recommended that the names *goyazite* and *hamlinite* be discarded for *strontiohitchcockite*, that of *gorceixite* for *bariohitchcockite*, etc.

It is concluded from the analyses that the Texas mineral is an isomorphous mixture of *kalioalunite*, *natroalunite*, *kaliohitchcockite*, and *natrohitchcockite*, admixed with some clay (*cimolite*). The California mineral is essentially *natroalunite*, with a little *kalioalunite*, and a large amount of impurities.

An analysis (by Whitfield) and description of impure manganese dioxide is given, found loose in the soil near the vicinity of the proposed Appalachian Park, Tennessee. It approaches the so-called "lithiophorite." No "mineral composition" is to be derived for *psilomelanite* (name written thus for uniformity), but it is to be regarded as composed essentially of the various oxides, Li_2O , Na_2O , K_2O , MnO , CoO , NiO , present as gels, united to the MnO_2 gel by adsorption.

Titanite from a trap quarry on the east side of the Delaware River, 2 miles north of Lambertville, is described, with analysis by Whitfield. The mineral occurs in yellowish-brown acicular crystals, imbedded in datolite, and is remarkable for its habit and its high Fe_2O_3 content. S. G. G.

PHILADELPHIA MINERALOGICAL SOCIETY TWENTY-FIFTH ANNIVERSARY MEETING

October 11, 1917

Address..... The President
The Founders..... Mr. James Richardson
Reminiscences..... Mr. Howard R. Goodwin
Mineralogical Research..... Dr. Edgar T. Wherry

The meeting will be followed by an exhibition of local minerals and a smoker.

FIELD TRIPS

Sunday, September 16. Mineral Hill, Black Horse and vicinity. Meet at 69th St. Terminal at 8.45 A. M.

Sunday, September 30. Phoenixville. Meet at the Reading Terminal, 7.15 A. M.

Sunday, October 14. DeKalb Street Quarries, and Henderson. Meet at 69th Street Terminal, at 8.45 A. M.

SAMUEL G. GORDON, *Secretary*.

EXCHANGE NOTICES

John Holzmann, 182 Ridgewood Ave., Newark, N. J., offers some of the most recent finds in New Jersey, including *pectolite* (new find), *prehnite* (crystallized), *thaumasite*, *stevensite* (See *Am. Min.* 1, (3), 44, 1916), *diabantite*, etc.